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(54) Variable capacity gear pump

(57) A gear pump of variable capacity and transfer rate but fixed rotational speed comprises a drive shaft 1 carrying a drive gear 3 and an axially movable idler shaft 2 carrying an idler gear 4. A housing 6 for drive gear 3 is slidable along the drive shaft 1 and coupled for rotation therewith and a housing 7 for the idler gear 4 is disposed rotatably but axially fixedly in an end cover 8. The drive gear housing 6 is held rotatably between the idler gear 4 and a securing ring 16 on the idler shaft 2, whereby the drive gear housing 6 is constrained to move axially with the idler shaft 2.

Starting from a position in which the gears 3, 4 are completely engaged, the idler shaft 2 may be slid towards the idler gear housing 7. The idler gear 4 and the drive gear housing 6 move with the idler shaft 2, such that the gear 4 moves into its housing 7 and the drive gear housing 6 moves over its gear 3. In this way, the available extent of the gear 3, 4 for fluid transfer is decreased.

FIG.5.

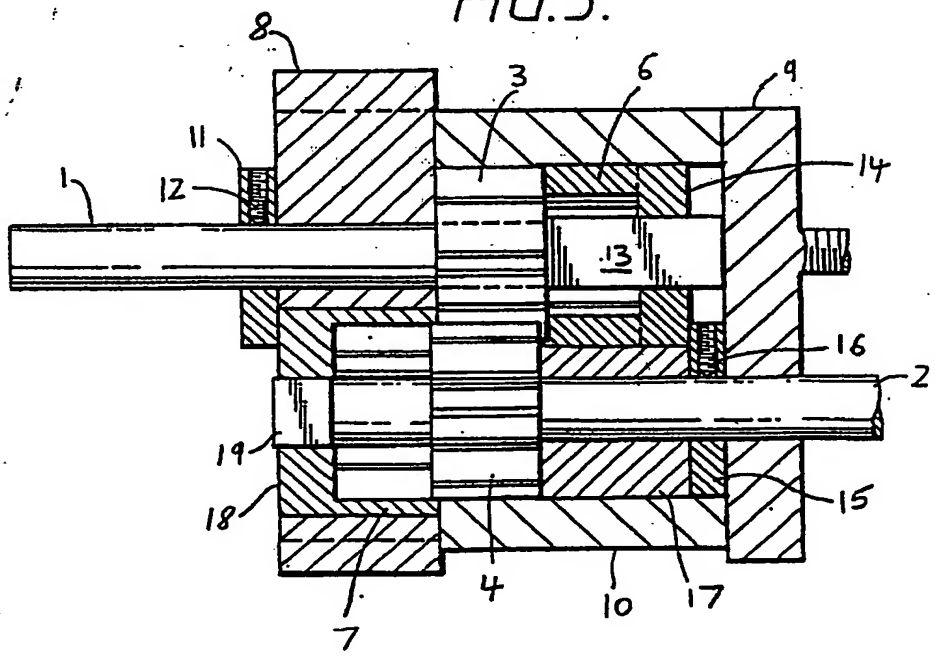

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FIG. 1.

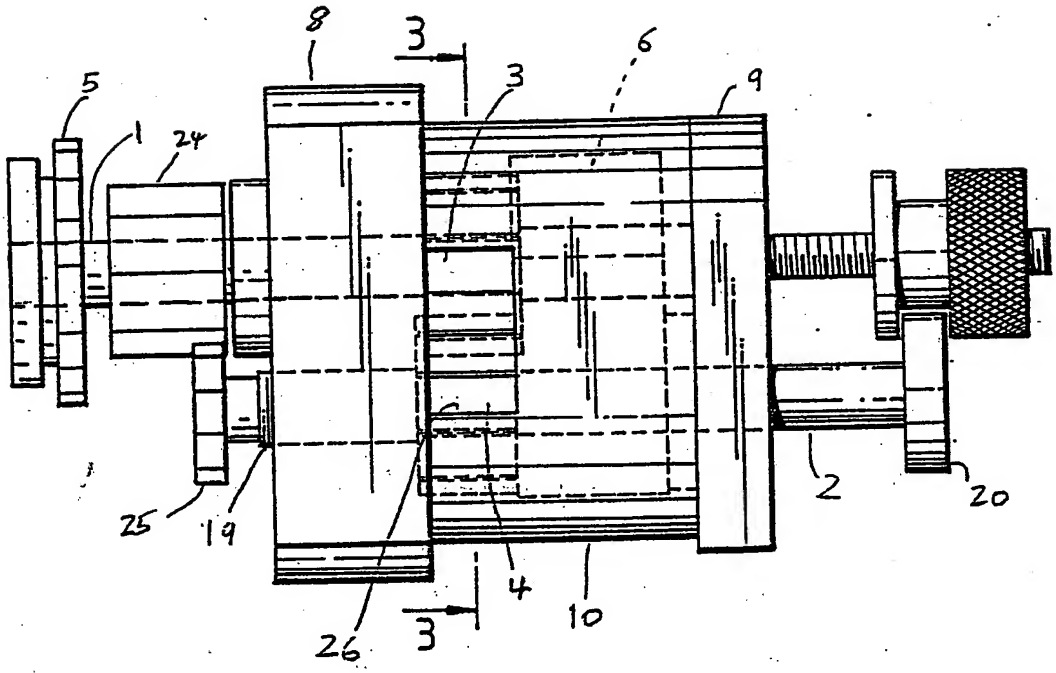


FIG. 2.

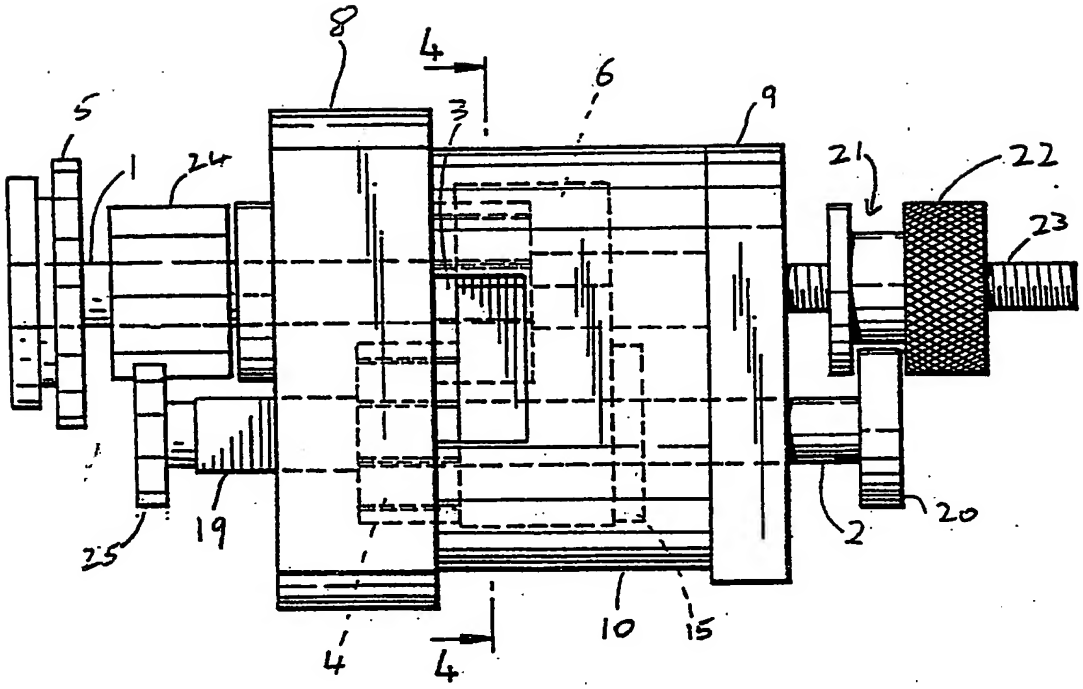


FIG. 3.

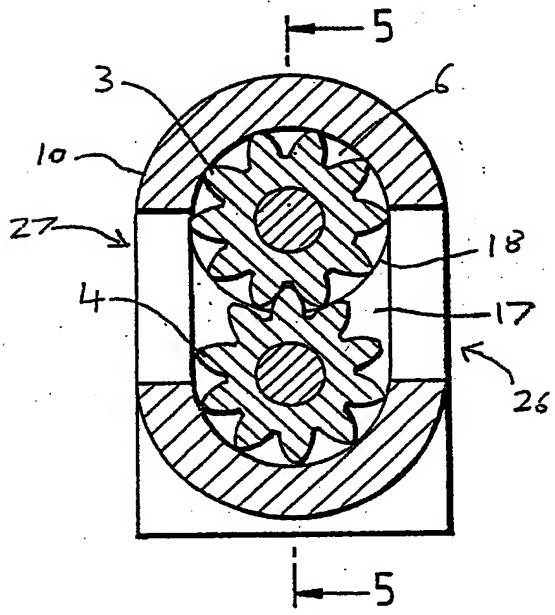


FIG. 4.

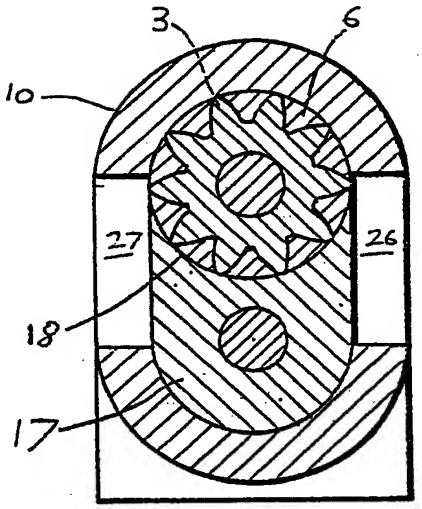
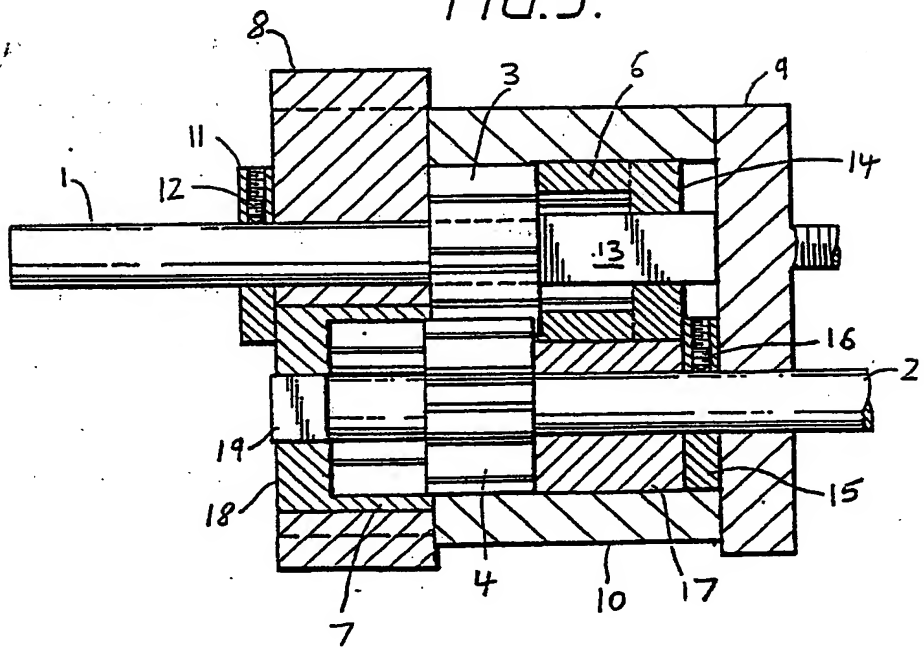


FIG. 5.



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Pump

The present invention relates to gear pumps.

Gear pumps are used to pump liquids in a wide variety of applications. Conventional gear pumps comprise a pair of interengaged gears mounted on parallel shafts and snugly contained in a body. One of the shafts is coupled to a motor which drives the shaft and its associated gear, which in turn drives the gear engaged therewith. An inlet port is arranged in the housing on one side of the gears. As the gears rotate, liquid from the inlet port is entrained by the gears and transferred to the opposite side of the gears, where the liquid leaves the pump through an outlet port.

Conventional gear pumps have a fixed capacity, and have a fixed flow rate unless the speed at which the drive shaft is driven can be varied. In practice, providing variable speed drive entails costs which are avoided where possible by providing a fixed speed drive. In order to provide for different rates of liquid transfer in different systems, a range of gear pumps of different sizes is provided.

It would therefore be desirable to provide a gear pump whose rate of transfer can be varied whilst maintaining the gears at a constant speed of rotation. It would be preferable to provide such a gear pump whose rate of transfer could be reduced to zero.

Provision of a gear pump of variable capacity which could be used in systems requiring pumps of different capacities would likewise be desirable.

The present invention provides a gear pump comprising gear means whose axial extent available to transfer liquid may be varied. Thus there is further provided a gear pump in which the effective length of the gears is variable.

The invention also includes a gear pump wherein housing means is provided for the gear means and the housing means and the gear means are arranged for relative movement for the gear means to be accommodated to varying extents in the housing means. Desirably the pump comprises a respective housing means for each of the gear means of an interengageable pair of gear means, the housing means being disposed at opposite ends of the gear means, and wherein the gear means are, from a position with a high degree of overlap therebetween, in a relative sense movable axially apart into their respective housing means and are movable in the reverse direction outwardly of their respective housing means.

In preferred embodiments the housing means are adapted to receive the periphery of the gear means in a snug fit, are rotatable and are coaxial to their respective gear means. In such embodiments it is preferable that each housing means is rotationally coupled to its respective gear means (e.g. by the housing means and gear means being driven by a common shaft) and the pump further comprises synchronising gears for keeping the gear means synchronised even if disengaged.

It is preferred that the gear means are both fixed to their respective shafts and a said shaft is axially movable and connected for axial movement with the housing means for the gear means fixed to the other said shaft.

In one preferred embodiment the invention resides in a gear pump comprising a gear housing for each gear. The gear housings are disposed at opposite ends of the gears. The gears are, from a position with a high degree of overlap therebetween, movable axially apart relative to one another and towards their respective housings such that, in a relative sense, the gears may move away from or towards one another out of or into a position with a high degree of engaging overlap therebetween and at the same time move inwardly into or outwardly from their respective housings. The gear housings are desirably rotatable. The gear housings are preferably arranged coaxially to their respective gears.

In another preferred embodiment the interengaging gear means on their respective shafts of a gear pump are axially relatively moveable from a position in which the gears are completely engaged (i.e. completely overlap) to a position where they are partially engaged (i.e. partially overlap) or are completely disengaged (do not overlap). Desirably, the gears may be selected to have any desired degree of overlap between the two extreme positions. The gear pump further comprises rotatable gear housings for the gear means on the respective shafts, the gear housings having an inner peripheral wall complementary to the respective gear means. The gear housings and the gear means are relatively axially movable between a position in which non-interengaging portions of the gear means are

completely or partially accommodated in the gear housings and a position in which a lesser axial extent (e.g. no axial extent) of each gear means is accommodated in its respective housing. Desirably the gear means and gear housings are relatively movable to enable accommodation of any desired extent of the gear means in the gear housings between the two extreme positions. Any portion of a gear means accommodated in a gear housing is not available to transfer fluid.

In another aspect, there is provided a gear pump comprising a pair of rotatable shafts, each carrying interengageable gear means. The gear means on one of the shafts has an axially fixed position. The gear means on the other of the drafts is axially movable between a position with a high degree of overlap with the other gear means and a position with a low degree of overlap with the other gear means. Normally, there is complete overlap in the high overlap position and complete disengagement (no overlap) in the low overlap position.

The pump desirably further comprises a rotatable gear housing for the gear means on each shaft. The gear housings' inner peripheral walls are complementary to the peripheral shape of the respective gear means. The housings are disposed coaxially to their respective gear means. The housing coaxial to the axially movable gear means is axially fixed. The housing coaxial to the axially fixed gear means is axially movable. The pump includes or is couplable to an axial mover means for axially moving both the axially movable gear means and the axially movable gear housing. The arrangement is such that when the gear means are in the high overlap position the gear housings do not engage overlapping portions of

the gear means but that in the low overlap position the gear housings substantially accommodate the disengaged extent of each gear means.

When the axial mover means is operated to change the pump from the high overlap position to the low overlap position, the mover means effects axial movement of the axially movable gear means out of engagement with the opposed gear means and into the axially fixed gear housing. Simultaneously, the mover means brings about axial movement of the axially movable housing to form a sleeve around the disengaged extent of the axially fixed gear means.

Since in this preferred embodiment the gear housings are axially rotatable, the gear means may continue to be driven when partially or totally received in the housings. The pump may therefore be operated with a high capacity and high fluid transfer rate when the gear means are in maximum overlap, with a low (e.g. zero) capacity and low (e.g. zero) fluid transfer rate when the gear means are in minimum overlap and accommodated to a maximum extent in the gear housings, or at any intermediate capacity and fluid transfer rate when the gear means are in an intermediate overlap position, all while the gears are being driven at a constant speed.

The gear pumps of the invention preferably comprise means for varying the size of the inlet and outlet ports of the pump with variation in the available extent or effective length of the gears. In those embodiments in which the position of the gears varies, the size of the inlet and outlet ports desirably changes with variation

in the position of the gears.

In preferred embodiments, the gear pumps comprise a drive shaft carrying a drive gear, both of which are in fixed axial relationship to an idler gear housing, and an idler shaft carrying an idler gear, both of which are in fixed axial relationship to a drive gear housing. A shaft of the pump is axially movable and the pump further comprises a slider block which is in fixed axial relationship with the movable shaft and juxtaposed to the gear housing on the other shaft; the gear and the slider block are arranged to move across the inlet and outlet ports as the axially movable shaft moves, to open and close the ports. In modified embodiments, it is only the slider block which closes the inlet and outlet ports.

The present invention is further described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a side view of a pump according to the invention which is in a high transfer position;

Figure 2 is a side view of the pump of Figure 1 in a low transfer position;

Figure 3 is a cross section along line 3-3 of Figure 1;

Figure 4 is a cross section along line 4-4 of Figure 2; and

Figure 5 is a partially sectional view along line 5-5 of Figure 4.

Referring to Figures 1 and 5, the drawings illustrate a gear pump which comprises a rotatable drive shaft 1 and a rotatable idler shaft 2 arranged in parallel therewith. The drive shaft 1 has secured thereto a drive gear 3. The idler shaft 2 has secured thereto an idler gear 4. In Figures 1 and 5 the idler gear 4 is shown as in almost complete overlap (complete engagement) with the drive gear 3. The gears 3, 4 are shown slightly out of complete engagement for the sake of clarity.

In use, the drive shaft 1 is coupled to a motor (not shown), for example by an external driving gear 5 (Figures 1 and 2).

Disposed coaxially to the drive gear 1 is a rotatable drive gear housing 6 designed to accommodate the drive gear 1. The drive gear housing may thus form a sleeve for the drive gear 1. Preferably, the external periphery of the drive gear 1 and the internal periphery of the drive gear housing 6 are complementary to one another, whereby the periphery of the drive gear 1 may snugly fit within the drive gear housing 6.

A rotable idler gear housing 7 (Figure 5) is located coaxially to the idler gear 2. The respective gear housings 6 and 7 are located at opposite ends of the gear assembly formed by the enmeshed gears 3 and 4, whereby the gears 3, 4 pass into their respective housings 6, 7 as they move axially apart relative to one another from the fully engaged position.

The pump is therefore so designed that, when considered in a relative sense, the gears 3, 4 are movable axially whereby, from a position of complete or high engagement, they may be moved apart from one another and, from a position of axial disalignment or separation. they may be moved towards each other. Further, the relative arrangement of the gears 3, 4 and the gear housings 6, 7 is such that, as the gears 3, 4 move from complete engagement (Figures 1 and 5) to substantial or complete disengagement (Figure 2), the gears 3, 4 enter their respective housings 6, 7. The axial extent of a gear enclosed in its housing is not effective for transferring fluid, i.e. the capacity or flow rate of the pump may be varied by changing the relative axial positions of the gears 3, 4.

Thus there is provided a gear pump wherein the effective extent or available length of the gears 3, 4 may be varied.

The relative movement of the gears 3, 4 and the gear housings 6, 7 is achieved in the illustrated pump by arranging the drive shaft 1, the drive gear 3 and the idler gear housing 7 to be in relatively fixed axial relationship. Indeed, these three components are axially fixed relative to the pump body and may conveniently be referred to as the "fixed assembly".

The idler shaft 2, the idler gear 4 and the drive gear housing 6 are likewise fixed axially in relation to each other. However the idler shaft 2, unlike the drive shaft 1, is slidable relative to the pump body and these three components may conveniently be referred to as the "slider assembly". Means is provided for

axially moving the slider assembly.

Axial movement of the slider assembly to the left in Figures 1 and 5 results in the idler gear 4 moving increasingly out of engagement with the drive gear 3 and into the idler gear housing 7. Simultaneously, the drive gear housing 6 moves over the drive gear 3. A position as shown in Figure 2 may then be reached. Continued leftward movement of the slider assembly will result in the drive gear housing 6 completely enclosing the drive gear 3 and the idler gear 4 moving completely into its housing 7.

In preferred embodiments such as that illustrated, the gear housings 6, 7 are provided with teeth to occupy the spaces between the teeth of the gears 3, 4, in order to maximise the loss of liquid transfer capacity as the gears 3, 4 enter the gear housings 6, 7. The gear housings 6, 7 in such embodiments are rotatable so that the gears 3, 4 may continue to be driven, eg at a constant speed, irrespective of their axial positions vis-a-vis the housings 6, 7. The gears 3, 4 are preferably rotatably coupled to their respective housings 6, 7, to ensure that each gear rotates in synchrony with its housing when it is completely free therefrom, if the particular pump permits the gears 3, 4 to be moved wholly out of the housings 6, 7. Such rotatable coupling may be achieved by arranging the gear housings 6, 7 to rotate with their respective shafts 1, 2.

Similarly, in embodiments wherein the drive gear 3 and the idler gear 4 may be totally disengaged, means is desirably provided to keep the two gears 1, 2 in

synchrony when disengaged.

Considering now the drawings in more detail, the gear pump shown has a pump body comprising a first end cover 8, a second end cover 9 and a side wall 10 extending between the two end covers 8, 9. The side wall has defined in it recesses 26 and 27 on opposite sides of the pump, for forming inlet and outlet ports. The drive shaft 1 is journalled through the first end cover 8 and extends along the pump body to the second end cover 9. The drive shaft 1 may be received in a bearing (not shown) at the second end cover 9.

Externally of the first end cover 8 a drive shaft securing ring 11 is secured around the drive shaft 1, for example by a setscrew 12. The drive gear 3 is fixed to the drive shaft 1 internally of the first end cover 8, for example by splines (not shown). The securing ring 11 and the drive gear 3 together act to resist longitudinal movement of the drive shaft 1 relative to the first end cover 8.

As shown in Figures 1 and 5, the drive gear housing 6 is provided on the drive shaft 1 on the opposite side of the drive gear 1 to the first end cover 8. The drive gear housing 6 is in the form of a cylindrical matching collar or cup to receive the drive gear 3. The drive gear housing 6 is arranged for rotation with the drive shaft 1. The drive gear housing 6 is axially slidable along the drive shaft 1 but arranged for rotation therewith. In the illustrated embodiment, rotational coupling between the drive shaft 1 and the drive gear housing 6 is effected by forming the drive shaft 1 with a square cross section in the region 13 along which the drive

gear housing 6 slides. The drive gear housing 6 has an end wall 14 arranged distally of the drive gear 3 and having defined therein a square bore complementary to the square region 13 of the drive shaft 1. In this way, the drive gear housing 6 is rotationally coupled to the drive shaft 1. Of course, alternative forms of rotational coupling may be used; in particular the drive shaft 1 and the matching bore defined by the drive gear housing 6 may be of any alternative non-circular, e.g. polygonal, shape.

The idler shaft 2 is journalled through the second end cover 9 for axial and rotational movement. An idler shaft securing ring 15 is secured to the idler shaft 2 inwardly of the second end cover 9. A setscrew 16, for example, provides suitable securing means.

On the opposite side of the securing ring 15 to the second end cover 9 the idler shaft 2 passes through a bore provided in a slider block 17. The slider block 17 is shown in transverse section in Figure 4. The slider block 17 is arranged to slide to and fro along the pump body without rotation. In the illustrated embodiment it fits snugly within the side wall 10 which holds the slider block 17 against rotation.

The slider block 17 has an arcuate upper surface 18 in which is seated rotatably the drive gear housing 6. The slider block 17 is disposed in a radially outward direction from the drive gear housing 6 and is contiguous therewith, such that the slider block 17 and the housing 6 may together close the recesses 26 and 27 as

described hereafter. On the opposite side of the slider block 17 to the securing ring 15 is fixed the idler gear 4 for axial and rotational movement with the idler shaft 2.

The drive gear housing 6 is constrained to move axially with the idler shaft 2 by the idler shaft securing ring 15 at one end of the housing 6 and the idler gear 4 at the other end of the housing. The idler shaft 2, the securing ring 15, the slider block 17, the idler gear 4 and the drive gear housing 6 therefore from a slidable assembly, all parts of which are constrained to move together axially. Alternative constructions for effecting axial movement of the drive gear housing 6 with the idler gear 4 may be adopted; preferably, however, the idler shaft 2 has provided on it abutment means for urging the drive gear housing 6 towards the drive gear 3 and the idler gear 4 is arranged to urge the housing 6 in the opposite direction.

The idler gear housing 7 is disposed rotatably within a bore in the first end cover 8. The idler gear housing 7 has an end wall 18 in which is formed a square bore complementary to a region of square cross section 19 at the associated end of the idler shaft 2. The idler gear housing 7 accordingly rotates with the idler shaft 2. The illustrated embodiment may be modified by use of alternative means for rotational coupling of the idler gear housing 7 and the idler shaft 2. The securing ring 15 is positioned to act as a stop to prevent the idler shaft 2 moving too far to the right (as viewed in Figures 1, 2 and 5) and out of engagement in the first end cover 8; alternatively, other stop means may be used.

The idler gear housing 7 is freely rotatable within the first end cover 8 but is held against axial movement by the drive gear 3 and abutment means provided externally of the end cover, shown as the drive shaft securing ring 11. In contrast to the slidable assembly, the drive shaft 1, the securing ring 11, the drive gear 3 and the idler gear housing 7 form a fixed assembly. Alternative constructions for holding the idler gear housing axially may be adapted.

It is not important whether it is the drive shaft 1 which is axially fixed and the idler shaft 2 which is slidable or vice versa. Rather, the important feature of the illustrated pump is that the assembly comprising the drive shaft 1, the drive gear 3 and the idler gear housing 7, on the one hand, and the assembly comprising the idler shaft 2, the idler gear 4 and the drive gear housing 6, on the other hand, should be axially movable relative to one another, whereby the gears 1, 2 move into their respective housings as they separate axially from the fully engaged (fully overlapping) position.

As the drive gear housing 6 and the slider block 17 move towards the first end cover 8 to reduce the capacity of the pump, so they move across recesses 26 and 27 in the sidewall 10 and progressively close the inlet and outlet ports of the pump.

Turning now to the external features of the pump, the idler shaft 2 is provided at its end extending out of the second end cover 9 with an annular flange 20. The flange 20 engages in an annular groove 21 provided around a thumbwheel 22,

which in turn is in threaded engagement with a shaft 23 fixed to the second end cover 9. The thumbwheel 22 may be moved axially in either direction along the shaft 23 by appropriate rotation of the thumbwheel 22. Axial movement of the thumbwheel 22 causes, via the idler shaft flange 20, sliding of the slider assembly (idler shaft 2, securing ring 15, slider block 17, idler gear 4, drive gear housing 6).

The pump shown in the Figures is a prototype and therefore provided with simple - but effective - means for moving the slider assembly. For some applications it would be desirable to provide alternative move means, for example an electronically controlled system responsive to the demands of the system such that the flow rate of the pump could be automatically adjusted as required.

At the other end of the pump, the drive and idler shafts 1, 2 are provided with enmeshing synchronising gears 24, 25. The synchronising gears 24, 25 are capable of remaining in engagement at all axial positions of the idler shaft 2. The function of the synchronising gears 24, 25 is to keep the drive gear 1 and the idler gear 2 in synchrony when they are completely disengaged. The synchronising gears 24, 25 may be dispensed with in embodiments in which the drive and idler gears 3, 4 cannot be completely disengaged.

CLAIMS

1. A gear pump wherein the axial extent of the gear means which is available to transfer liquid may be varied.

2. A gear pump as claimed in claim 1, wherein housing means is provided for the gear means, and the housing means and the gear means are arranged for relative movement for the gear means to be accommodated to varying extents in the housing means.

3. A gear pump as claimed in claim 2, which comprises a respective housing means for each of the two interengageable gear means, the housing means being disposed at opposite ends of the gear means, and wherein the gear means are, from a position with a high degree of overlap therebetween, in a relative sense movable axially apart into their respective housing means and are movable in the reverse direction outwardly of their respective housing means.

4. A gear pump as claimed in claim 3, wherein the housing means are adapted to receive the periphery of the gear means in a snug fit, are rotatable and are coaxial to their respective gear means.

5. A gear pump as claimed in claim 4, wherein each housing means is rotationally coupled to its respective gear means and the pump further comprises

synchronising gears for keeping the gear means synchronised even if disengaged.

6. A gear pump as claimed in any one of claims 3 to 5, wherein both the gear means are fixed to their respective shafts and a said shaft is axially movable and connected for axial movement with the housing means for the gear means fixed to the other said shaft.

7. A gear pump, comprising a drive shaft, a drive gear secured to the drive shaft, an idler shaft, an idler gear secured to the idler shaft and engageable with the drive gear, a drive gear housing disposed at one axial end of the drive gear, and an idler gear housing disposed at the opposite axial end of the idler gear, the gears being axially movable relative to each other and to their respective housings such that, in a relative sense, the gears may move away from or towards one another out of or into a position with a high degree of engaging overlap therebetween and at the same time move inwardly into or outwardly from their respective housings.

8. A gear pump as claimed in claim 7, wherein the gear housings are arranged coaxially to their respective gears and are rotatable.

9. A gear pump as claimed in claim 8, wherein each gear housing has an internal periphery complementary to the outer periphery of its respective gear.

10. A gear pump as claimed in claim 9, wherein each gear housing is coupled

for rotation with its respective gear.

11. A gear pump as claimed in any one of claims 7 to 10, which comprises means for varying the size of the inlet and outlet ports of the pump with variation in the position of the gears.

12. A gear pump as claimed in any one of claims 7 to 11, wherein each of the drive and idler shafts is in substantially fixed axial relationship to the gear housing for the gear secured to the other shaft and a said shaft is axially movable.

13. A gear pump as claimed in claim 12, wherein the axially movable shaft has provided on it abutment means for sliding the gear housing for the gear secured to the other shaft towards that gear and the gear secured to the axially movable shaft is arranged for sliding the gear housing away from the gear.

14. A gear pump as claimed in claim 12 or claim 13 and which comprises means for varying the size of the inlet and outlet ports as claimed in claim 11, wherein the means for varying the size of the ports comprises the gear housing in fixed axial relationship with the axially movable shaft and a slider block in fixed axial relationship with the axially movable shaft and contiguous with said gear housing, the gear and the slider block being arranged to move across the ports as the axially movable shaft moves.

15. A gear pump as claimed in any one of claims 12 to 14, wherein the other

said shaft is axially immovable.

16. A gear pump as claimed in claim 15, wherein the gear housing in fixed axial relationship to the axially immovable shaft is disposed in a bore in an end cover of the pump and is held against axial movement between the gear secured to the axially immovable shaft and an abutment means provided externally of the end cover.

17. A gear pump as claimed in claim 16. wherein the abutment means is provided on the axially immovable shaft.

18. A gear pump in which the effective length of the gears is variable.

19. A gear pump substantially as hereinbefore described or as illustrated in the accompanying drawings.

Patents Act 1977
E. miner's report to the Comptroller under Section 17 (The Search Report)

Application number

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Relevant Technical fields

(i) UK Cl (Edition L) F1F (FEP)

(ii) Int Cl (Edition 5) F01C, F04C

Search Examiner

C J DUFF

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

24 MAY 1993

Documents considered relevant following a search in respect of claims 1-19

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1539515 (ROLLS ROYCE) Whole document	1,2,18
X	GB 1429474 (BRITISH STEEL) Whole document	1,2,3,4 18
X	EP 0478514 A1 (BUSSI) Whole document	1-4,6-10 18
X	US 4740142 (ROHS...) Whole document	1,18

Category	Identity of document and relevant passages	Relevant to claim(s)

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